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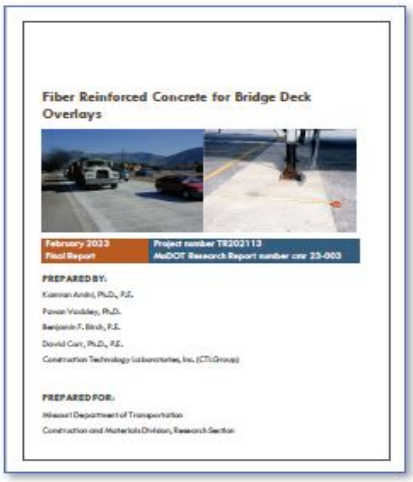
Research Summary

Fiber Reinforced Concrete for Bridge Deck Overlays



Bridge deck deterioration is primarily caused by environmental factors and heavy traffic use. Being the most exposed element of bridges, concrete bridge decks are often the main contributor to the reduction in serviceability of a bridge. Cracking, freezing and thawing, and chloride ingress are the predominant deterioration mechanisms affecting the performance of the concrete bridge decks in Midwest states, such as Missouri, where de-icing salts are widely used. For these reasons, concrete overlays have been used as a traditional but advanced tool to extend the life of the reinforced concrete pavements and bridge decks.

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Among many other challenges in incorporating fibers in concrete overlays, fiber dispersion is the most frequently encountered performance challenge associated with FRCs (fiber reinforced concrete). Improper distribution of the fibers can lead to agglomeration, which will affect the performance of FRC in both fresh and hardened states. Although thin concrete overlays are assumed to have improved bond with the substrate when they contain fiber reinforcements, bond of FRC overlays with the substrate is also another element that has been overlooked within literature. Fiber dispersion problems can vary depending on the fiber type and mixture proportion, and therefore, necessitate the appropriate combination of fiber type and concrete mixture proportions. Another challenge of FRC use for overlays is coming up with the correct combination of fiber type and dosage. The dose of fiber necessary to achieve a certain level of performance will vary from one fiber to the next so it isn't enough to specify a certain dosage of fiber. This can be overwhelming due to the wide variety of fibers available in the market and the inherent effect of the use of different fibers on concrete performance.

Overlay history shows the most common failure modes are mid- and corner-panel cracking, joint faulting, curling, lack of ductility, and fatigue. Fiber reinforcement can help mitigate these failure modes. Improved resistance to crack propagation, controlled thermal and moisture stresses, increased elasticity, higher tensile, flexural, and fatigue strengths, and greater impact and abrasion resistance are some improvements in performance that are can be achieved in using FRC.

Despite many laboratory and field studies carried out in the past to study the use of FRC for overlays, there are a myriad of different exposure and use conditions. In result, there is no universally agreed upon set of criteria and tests

for evaluating FRC for overlays. There is no universally agreed upon set of criteria and tests for evaluating FRC for overlays. A lack of criteria means there is a need for study into the appropriate methods examining the value of using FRC in a variety of intended service conditions. Therefore, the development of a Performance Engineered Mixtures (PEM) program for FRC overlay is essential. The goal of a PEM is to achieve the service life of the design through measuring and controlling the concrete mixture by the engineering features that relate to the performance of the concrete.

The potential of FRC overlay requires more work under the PEM program, with two main steps: 1. Develop a provisional specification and 2. Upgrade existing and/or develop new test methods. This requires identifying the properties controlling the FRC overlay mixture performance, followed by developing correlations among the available test methods and the controlling-performance properties.

Therefore, there is a need to (1) establish a systematic and functional process that can guarantee the success of the FRC overlay application, (2) develop performance criteria for acceptability, (3) establish defined protocols for agencies to be able to evaluate a product that is submitted for approval, and (4) identify methodologies that facilitate the decision-making process.

Figure 1: FRC bonded on asphalt.

Project Information

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